Research of Influence of Collected Details form Deviation on the Accuracy of Precision Assembly

N.Mozga[1], I.Grinevichs[1], I.Brensons[1]
[1]*Riga Technical University, Institute of Mechanical Engineering, Latvia*

natalija.mozga@rtu.lv

Abstract

In given article it is shown that at the automated precision assembly it is possible not to measure a form deviation of the details, but sort them, using inexpensive means of certification of the details sizes.

1 Tasks of precision assembly

The main task of precision assembly is to guarantee of goods performance. Production characteristics of engineering products are defined, as a rule, by accuracy of assembly, which main part of cases depends on deviation of dimensions and form of collected details. Result of violation of assembly accuracy requirements, particularly of no allowable deviation of geometrical form of work surfaces of collected details, is loss of lubricant of fuel through out precision surfaces, seizure of moving parts and other undesirable consequences.

In this case conditions of stocking and assembling of details have the special role in maintenance of quality and reliability of precision equipment. In the course of details assembly: 1) have to be removed adverse combinations of constructive-technology factors, which have an influence of final parameters; 2) has to be ensured maximally possibly not changeable parameters of equipment; 3) and has to be ensured defined character of connection. At assembly of precision connections for achievement of the required accuracy of the closing dimension mainly apply a method of group interchangeability (selective assembly). At this method high requirements to the geometrical form of details should be ensured.

2 Selective assembly of precision parts

In many enterprises precision components and products are manufactured in mass quantities. Typical is the production of precision pairs of diesel fuel injection

equipment, production of which reaches tens of millions of pairs a year. Similar precision pairs are, for example, plunger pairs of high pressure sections of diesel fuel pumps for tractor and combine engines.

At selective assembly of precision parts the precision measurement of actual size and its labelling to the appropriate group has decisive importance, because these determine the deviation value of the closing link (for example, clearance) and, thus, the quality of the product. Processes of measurements and sorting at assembly consist in following: the details manufactured of set tolerance have to be divided into groups.

So, after carrying out of finishing operations high-precision details of plunger pair go at a position of the form deviations control.

3 Measuring of form deviations of precision pair

For experimental measurements two batch of complete sets of details of plunger pairs - on 10 complete sets in everyone have been selected. Bushings in these batches had diameters close to most often occur during assembly.

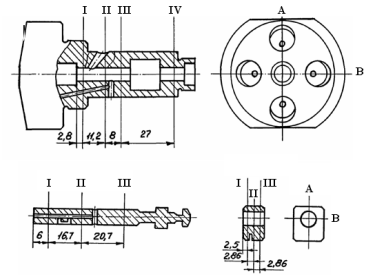

Figure 1: The sketch of details of plunger pair of diesel fuel pump

The analysis of geometry of a precision cylindrical surface of bushings has shown, that the most typical form deviations for this surface are a deviation of axes straightness, deviation of roundness in various cross-section sections, bow of the top part of inner surface of the bushing (between sections I and III, Figure 1), taper (sections II-IV). For plunger axes straightness is provided with finishing technology, but it has deviations of roundness (lobing), basically, in section I and taper. For

metering device characteristic form deviations are deviations of roundness in cross-section sections, taper, barrel and bow. All these form deviations to a greater or lesser extent influence both mobility, and on hydrodensity of connection.

In order to determine the basic dimensions (diameter in the middle section) and to identify mentioned in this article form deviations of details of selected batches, carrying out a minimum number of different measurements, the following geometric dimensions have been measured:

- Diameters of bushings in sections I ÷ IV, and the deviations of the axis straightness. In each section diameters were measured in two perpendicular directions - A and B (Figure 1);
- Diameters of plungers in sections I ÷ III and quantities of lobing in section I;
- Diameters of metering device in sections I ÷ III in two directions A and B in each section.

4 Determination the clearance in precision pairs

As a result, it was stated that the presence of such form deviations in longitudinal section leads to a redistribution of the diametrical clearance size along the length of the pair and arouse appearance of the so-called "jamming." In this case, the shaft does not have free movement under its own weight. Therefore, the main parameters determining the possibility of an assembly of precision parts are camber of shaft and hole axis and the size of diametral clearance. There are the next condition of the assembly of plunger pair: the diametrical clearance has to be greater than the sum of the camber of shaft and hole axis.

After measuring the detail size details are sorted by the measured dimension, and then is determined the group number for details. During sorting provides rejection of parts, which measured size goes beyond the manufacturing tolerance. According to the results sort of details is done the complication of pairs by method of group interchangeability. Then for ready connections is defined clearance, taking into account the deviations of the correct geometric form. The size of the hole is evaluated equal to the minimum value (taking into account the camber of its axis), but the shaft size – to the maximum value. Consequently, the diametrical clearance in the precision pair is equal to the difference between the diameters of the holes and

the shaft and is a minimum clearance of the connection in longitudinal section. If the clearance in the pairs goes beyond tolerance, the pair is considered to be defective.

At testing clearance in connection is determined for two cases of operating conditions (results are shown in Figure 2):

1) minimum clearance at turning of the shaft relative to the bushing (Figure 2 – continuous lines);

2) random clearance at forward motion of the shaft relative to bushing (Figure 2 – dashed lines).

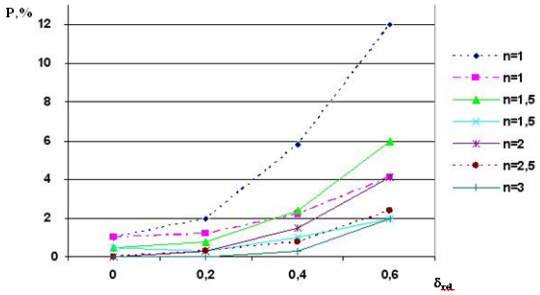

Figure 2: Dependence of the assembly probability *P* from the relative value of camber of details axis $\delta_{rel.}$ at change of group tolerance in *n* times

Conclusions:

The data analysis shows that with increasing of camber of details axis the number of defective connections increases. Decreasing the group tolerance in the 2 ... 2.5 times can reduce the proportion of defective connections at 70 ... 80%.

References:

[1] В.Я.Катковник, А.И.Савченко. Основы теории селективной сборки. – Л.: Политехника, 2001. – 303 с.

[2] Рабинович, Л. А. Исследование точности соединений при многовариантных схемах сборки с групповой взаимозаменяемостью. Вестник машиностроения. –1991. – № 6. – С. 44–47.

[3] N.Mozga. Optimization of technological process for assembly on rotary assembly machines. Promotion work. Riga, Latvia. 2004.